
Jason Freeman

Glimmer

**for chamber orchestra
and audience**

(15-player version)

Score

Jason Freeman
Glimmer (2004)
for chamber orchestra and audience

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***Glimmer* was commissioned by the American Composers Orchestra,
Steven Sloane, music director, Robert Beaser, artistic director,
Dennis Russell Davies, conductor laureate.**

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the American Music Center.**

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director) and to the Columbia University Computer Music Center
(Brad Garton, director).**

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This score is intended for use by conductors, management, technical personnel, and anyone else interested in learning more about the piece.

I did not write this score linearly from start to finish, so you need not read it linearly from start to finish.

If you are looking for time-based notation to follow while listening to the piece, skip to the timeline.

Supplementary DVD Contents

The supplementary DVD includes three simulations of *Glimmer*:

- **Simulation of One Musician Light (no audio).** This simulation shows a single musician's light over the course of a performance. It is intended for use during individual practice. Please note that there are long periods of silence (i.e. black light) in the opening and closing minutes, due to the structure of the piece.
- **Simulation of All Musician Lights with Audio.** This simulation shows the lights for all twenty-five musicians. Each colored square represents the light for a single musician. The arrangement of lights on the screen corresponds to the suggested seating chart (see Seating below). The audio simulation of the orchestra is *extremely* crude. Use it as a means to better understand how the piece works, not what the performance will sound like.
- **Video Projection (no audio).** This track shows the video projection which the audience sees during the performance. Each colored rectangle represents a group of musicians / audience members. The arrangement on the screen corresponds to the suggested audience seating chart (see Seating below).

Please note that these simulations correspond to the original 25-player version, not to this 15-player version.



About the Piece

Glimmer engages the concert audience as musical collaborators who do not just listen to the performance but actively shape it. Each audience member is given a light stick which he or she waves over the course of the piece. Computer software analyzes live video of the audience and sends instructions to each musician via multi-colored lights.

I wrote *Glimmer* because I wanted to directly involve listeners in the creative process within a traditional concert setting. I hope that their participation will lead them to hear the music in a different way and to have some fun.

Duration

Glimmer lasts exactly ten minutes.

Allow five additional minutes just before the piece begins to explain to the audience how to participate.

Instrumentation

The fifteen musicians in the orchestra are divided into five groups. The music each group of musicians plays is influenced by the actions of a corresponding group of audience members.

GROUP A

Violin I-1
Violin I-2
Violin I-3

GROUP B

Violin II-1
Violin II-2
Violin II-3

GROUP C

Viola 1
Viola 2
Viola 3

GROUP D

Cello 1
Cello 2
Cello 3

GROUP E

Bass 1
Bass 2
Bass 3

The piece is performed without a conductor.

Performance Notes

Bowing

Do not attempt to synchronize your bowing with other players, since each player receives independent instructions.

Try to play sustained notes in a single bow. When this is not feasible, change bowing as smoothly as possible.

Timbre

As dynamics vary from *pp* to *ff*, gradually change from *poco sul tasto* to *poco sul ponticello*.

Strings

Violin I-1 and Violin I-3 should use *sul A* throughout.

Violin I-2 should use *sul D* throughout.

Violin II-1, Violin II-2, and Violin II-3 should use *sul G* throughout.

Viola 1 and Viola 3 should use *sul D* throughout.

Viola 2 should use *sul G* throughout.

Cello 1 and 3 should use *sul D* throughout.

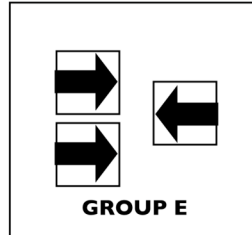
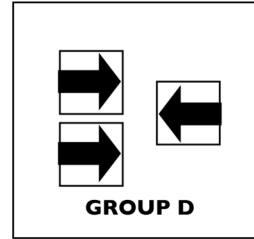
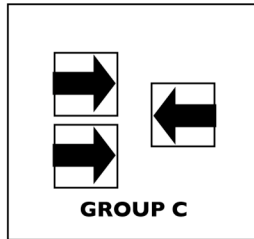
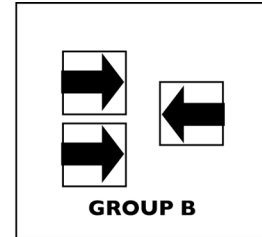
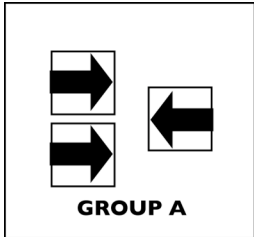
Cello 2 should use *sul G* throughout.

Seating

Orchestra

Suggested Seating Arrangement

STAGE FRONT



Arrows indicate the direction each musician faces.

Audience

Group Divisions (Hamabada Art Center)

Group A: rows 1-4, seats 1-10

Group B: row 1, seats 30-39

row 2, seats 34-44

row 3, seats 38-47

row 4, seats 42-51

Group C: row 1, seats 23-29

row 2, seats 26-33

row 3, seats 29-37

row 4, seats 32-41

Group D: row 1, seats 11-17

row 2, seats 11-18

row 3, seats 11-19

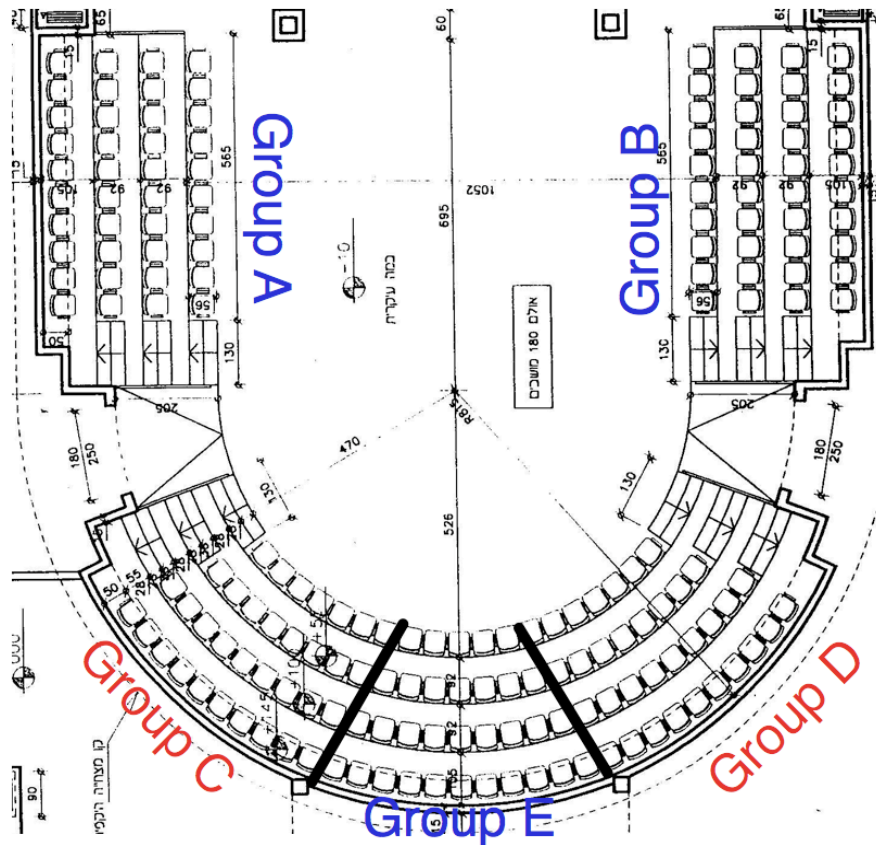
row 4, seats 11-20

Group E: row 1, seats 18-22

row 2, seats 19-25

row 3, seats 20-28

row 4, seats 21-31



Red groups use red light sticks, blue groups use blue light sticks.

Other Group Divisions

The audience may be divided in different ways in different halls, so long as:

- Each group contains approximately the same number of people.
- Directly adjacent groups alternate between red and blue light sticks, as with Groups A-E in the figure. (This helps the video analysis software and the group members themselves accurately recognize group boundaries.)

Notes for the Audience

Introduction to the Piece

Just before the performance begins, someone — preferably the conductor — must explain to the audience how to participate. Here is a sample text:

Glimmer engages you not only as a listener, but also as a musical collaborator who actively shapes the performance. As you wave a light stick around over the course of the ten-minute piece, computer software will interpret your actions by analyzing live video of the audience, and it will relay instructions to the orchestra by changing the colors of lights on each player's stand.

You are seated in one of five audience groups, and your group controls a specific section of the orchestra. The music played by that section depends on how fast all of the people in your group are waving their light sticks. The music also depends on how your group's light-stick activity changes over time, and on how it compares to the activities of other groups.

Go ahead and turn on your light stick now (simply twist it). Great!

We have divided the audience into five groups (A through E), and each of those groups is linked to a group of three musicians in the orchestra. By using your light sticks throughout the piece, you directly affect what those musicians play. Let's take a moment to look at each group:

[Screen shows slides with audience groupings.]

GROUP A is (row and seat numbers).

You are linked to the first violins.

GROUP A, let's practice for a minute — keep your light sticks completely still. OK, now start moving them back and forth really fast, all together. OK, now bring them back still again.

[Do the same with groups B, C, D, and E.]

Now that you know how to participate, let me quickly explain how the piece works. At the most basic level, when everyone in your group moves their light sticks faster, your musicians will play louder. Sometimes, the notes they play will pulsate faster or the timbre of their sound will become more intense as well.

At a higher level, there is a competition of sorts among all five audience groups. Audience groups which do more interesting things are rewarded — their musicians become more prominent in the orchestra, and often something about what they play will change. Audience groups which do less interesting things are...not rewarded. Their musicians become less prominent within the orchestra, and sometimes — especially at the beginning and end of the piece — they will not play at all.

So what does it mean to be interesting? Here's a hint: if everyone in your group waves your light sticks wildly around for the entire piece, that's not very interesting. If everyone in your group leaves their lights completely still for the entire piece, that's also not very interesting. But if your group works together, however that may be, to gradually change what you are doing over time, then that could be interesting and your group may do quite well.

Throughout the piece, listen for your musicians in the orchestra; the music is very simple to help facilitate that. There is also a computer animation on the video screen which will help you follow what is going on in the piece. Each group is represented by a rectangle. The faster your group waves your light sticks, the brighter the rectangle. And the most interesting group at any moment has a circle around its name.

There is no conductor for the piece, so there is no downbeat to begin. I'll just leave the stage, the lights will dim, and go ahead and start whenever you are ready.

Notes for the Conductor

What am I supposed to be doing?

This piece is performed without conductor. The musicians are directed by the multi-colored lights mounted on their stands. Those lights are controlled by the computer, and the computer is in turn controlled by the audience. The music begins when the first audience member turns on his or her light stick, and the computer software automatically ends the piece by fading out all of the musicians' lights.

The multi-colored lights are a necessity, because each musician in the orchestra receives independent instructions generated in real time by the computer, and no conductor can communicate fifteen different messages to fifteen different players simultaneously.

Your role is to prepare the orchestra in rehearsals and to prepare the audience just before the piece begins.

Rehearsals

Strictly speaking, *Glimmer* is not possible to rehearse without a full audience. But the computer software can simulate audience interaction, and the multi-colored stand lights and computer equipment can be set up at each rehearsal. So it is possible to approximate the performance environment.

These are some of the challenges which may need to be addressed:

- **Help musicians learn to respond to the multi-colored lights.** Musicians will be given a practice DVD along with their part, but the rehearsals are their only chance to practice with the actual lights.

- **Adjust dynamic range and balance.** Each multi-colored light can display the same range of colors, and each musician should respond to those colors with the same range of dynamics. *ff* should be approximately equal in perceived loudness, whether played on violin, viola, cello, or bass.
- **Adjust accents.** Accents should be clearly articulated so that they stand out from the ensemble.
- **Work on tuning.** Good intonation is critical to a successful performance of *Glimmer*, yet it is impossible to predict exactly which simultaneities will occur in the performance. Each group of musicians can tune unison notes and clusters individually, and the orchestra can rehearse tuning a variety of chords which are likely to occur.
- **Deal with unexpected catastrophes.** Discuss how to respond to a technological catastrophe during the performance.

To facilitate rehearsal, the computer software can be quickly cued to start from any rehearsal marking on the timeline (see Timeline below). The piece can also be “frozen” — by pausing at any point in the timeline, pausing data from the simulated audience, and pausing color changes in the musician lights — in order to isolate and rehearse a particular situation.

Audience Introduction

Just before the performance of *Glimmer* begins, explain to the audience how to participate (see Notes for the Audience above).

Notes for the Performers

Individual Practice

Glimmer is a difficult piece to practice; it is impossible to predict exactly what you will be asked to play during the performance. Here are some suggestions for how best to prepare:

- **Practice with the supplementary DVD.** The DVD includes a computer simulation of the light which will be mounted on your music stand, showing how the light changes color over the course of a performance. Use it to learn what to expect and to practice how to respond.
- **Memorize your part.** There will probably not be enough light on stage during the performance for you to read your music.

- **Practice intonation.** Work on playing the four notes in your part consistently in tune over a full dynamic range.

Interpretive Freedom

The directions given to you by your multi-colored light intentionally leave some things open to interpretation, so that you can make musical decisions during the performance based on what you hear around you.

- **Accents.** From time to time, you are directed to attack notes with accents, but you are never told how much to accent those attacks. Use your judgment to make sure that your accent will be heard prominently above the rest of the orchestra, but will not be so excessive as to sound out of place.
- **Dynamics and timbre.** You are instructed to change dynamics and (for most instruments) timbre and/or vibrato as well, based on the brightness of your light. You will probably discover that there is a margin of error in the accuracy and consistency of your response to brightness, especially after changes in color or long periods of black (silence).

Take advantage of that margin of error! You can (and should) vary your response to a small degree, in order to blend with the other players in your group, react to the music you hear around you, and help to push the music in whatever direction you think it is going.

Unexpected Catastrophes

It is unlikely, but always possible, that something will go wrong during the performance. In particular, your light, or all of the lights, may stop working.

If this happens, try to continue as best you can. If your light goes black, stop playing. If your light freezes on a color, then continue playing as that color directs you.

Here is what might happen next:

- **The problem is quickly resolved.** The light(s) start working again and the performance continues.
- **The problem needs more time to be fixed, and the performance must be stopped.** Someone will come out on stage to alert you and give you further instructions.
- **The problem cannot be fixed at all, or the piece is almost over.** The power to all the lights will be cut off, sending them to black. Stop playing, and the piece will end.

Notes for the Management

Equal-size Audience Groups

The analysis algorithms used in *Glimmer* assume that each audience group is approximately equal in size. If the audience is not evenly distributed, smaller groups will be favored, and their musicians will tend to dominate the orchestra. And if an audience group is empty, then the corresponding group of musicians will be silent for the entire piece.

To avoid these problems, keep track of box office sales and try to predict which areas of the audience may be empty or nearly empty during the performance. Adjustments to audience groupings can be made in the computer software a few days before the concert in order to accommodate such situations. Or if the logistics of the venue permit it, audience members can be asked to change seats at the concert in order to create a more even distribution.

Light Stick Distribution

Ushers should distribute light sticks to audience members just before the performance of the piece begins.

Different audience groups use different color light sticks. If an audience member uses the wrong color light stick, his or her actions will not affect the music.

House and Stage Lighting

For accurate video analysis of the audience, the entire hall must be as dark as possible during both the performance and the explanation which is given to the audience just beforehand:

- **No stage lights can be used.** The only stage lighting comes from the video projector and the multi-colored lights on each musician's stand. (During the introduction, a single dim light may be used for the person introducing the piece.)
- **The house must be totally dark** except for emergency lighting.
- **Do not open any house doors** during the introduction or the performance.

Technical Setup Time

On the day of the concert, **approximately five hours** are needed to set up and test all of the equipment for the concert. If the hall is available for five hours the day before the performance, then only one hour is required on the performance day.

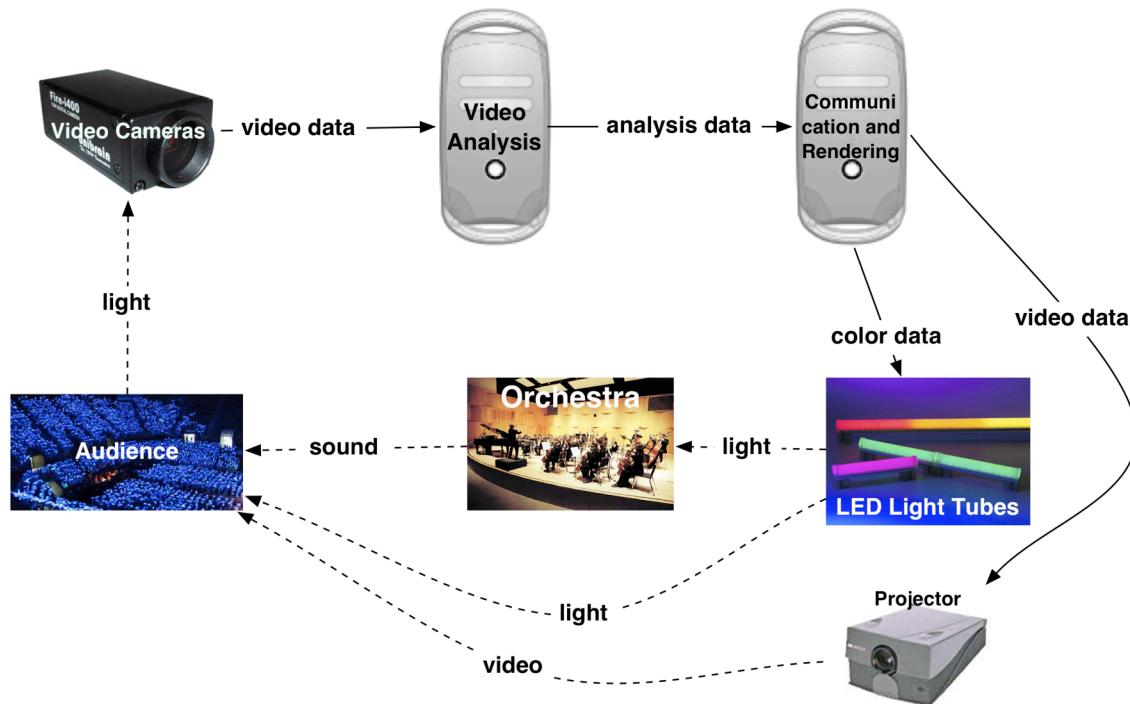
Most of this setup can be done quietly while other work takes place in the hall. But for the last **hour** of that setup time, the stage and house lights must be completely dark, just as they will be during the performance (see House and Stage Lighting above).

Dress Rehearsal

During the dress rehearsal, do a complete run of the piece with a small audience:

- Stage and house lighting must be completely dark (see House and Stage Lighting above).
- At least fifteen people must be available to act as audience members (three per group). The more people participate, the better.

High-Level System Overview

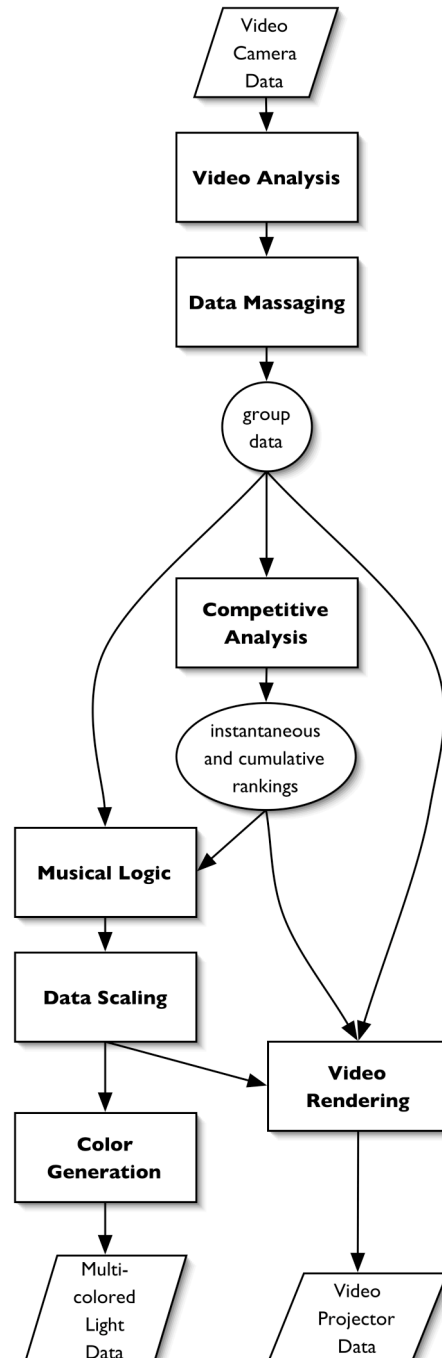


Conceptually, *Glimmer* is designed as a continuous feedback loop. Solid lines indicate physical wires connecting components. Dotted lines indicate “wireless” communication — of sound and video to ears and eyes, or of light sticks to video cameras.

Audience members wave their light sticks around. That changes the video images captured by the cameras. That video data is turned into analysis data and then, through musical logic running on the computer, into color data for the multi-colored lights and

video data for the projector. The musicians react to the lights to play the music. The audience, in turn, reacts to the music they hear, the video they see, and the lights they see — by making changes to their light sticks, and thus beginning another loop through the system.

High-Level Software Overview



This figure presents a high-level overview of the various software components and the flow of data through them. The following sections give high-level descriptions of each of these software components.

All of the software is written for use with Cycling '74's Max/MSP 4.5 and Cycling '74's Jitter 1.2 on Mac OS X 10.3. Complete source code is available upon request.

Video Analysis

Goal

- Compute the amount and energy of light-stick waving for each group as a number between 0 and 1.

Technique

- Grab video from the cameras at a rate of at least 4 frames per second.
- Adjust image brightness, contrast, and saturation to maximize accuracy.
- Create five image buffers, one for each group.
- When a new frame of video is received, do the following for each buffer:
 - Copy the most recent video frame into the buffer.
 - Reduce the video frame to a single-plane (grayscale) image:
 - When two groups are close together, extract the red or blue plane from the color image (for red or blue light sticks, respectively). Then set all pixels to black in which the extracted plane's luminosity is lower than the luminosity of either of the other two color planes.
 - When a group is physically separated from other groups, simply convert the color video image to grayscale based on the total luminosity of each pixel.
 - Apply an image mask to black out extraneous areas of the frame (e.g. areas which show other audience groups, emergency lighting, or nothing at all).
 - Reduce background noise by applying a threshold filter which blacks out pixels below a given luminosity.
 - Add up the total luminosity of all of the pixels in the image. (When audience members wave their light sticks, the sticks get "blurred" in the image and sum up to more pixels.)
 - Divide the pixel sum by the maximum pixel sum found so far.

Notes

The software includes real-time GUI controls for several parameters:

- Image masks, which can be drawn onto the video image, saved as graphics files, and reloaded on application startup.
- Threshold filter values.

- Brightness, contrast, and saturation values.
- Maximum pixel sums and auto-update of maximums.
- Plane extraction method.
- Gradient image scaling, in which the brightness of areas closer to the camera is reduced.

Data Massaging

Goals

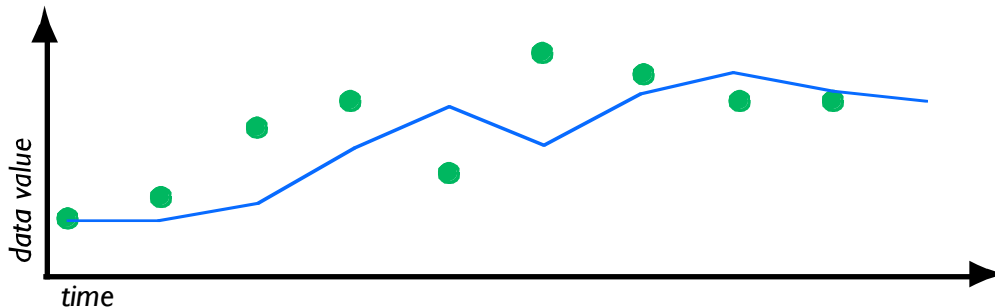
- Smooth out sudden changes in data which are artifacts of the video analysis algorithm.
- Interpolate data values between video analysis frames.

Technique

- Use a linear lag. When a new value is received, move towards it gradually and continuously over 500 ms, instead of jumping to it immediately.

Notes

- The software includes a mechanism to adjust this lag time during runtime.



In this figure, the green dots represent data values arriving from the video analysis component, and the blue line represents the massaged data values.

Competitive Analysis: Instantaneous

Goals

- Determine which group is currently the most “interesting” (i.e. has the fastest rate of change). Call this group the “winner.”
- Favor positive rates of change over negative rates of change in choosing the winner.
- Rank all groups based on how recently each has been the winner.
- Do not change winners too frequently.

- Do not change winners at regular time intervals.

Technique

- For each data set received from the data massager, do the following:
 - For each group's data value:
 - Compute the average difference between successive values over the last several values.
 - Add each group's inertia factor to this average difference.
 - Find out which group has the highest sum:
 - Name it the winner.
 - Move it to the front of the group rankings list.
 - If the winner has changed:
 - Set the old winner's inertia factor to 0.
 - Set the new winner's inertia factor to 1, then gradually let it decay to 0 along an exponential curve. Set the decay time to between two and six seconds: the *lower* the current data value for the new winner, the *longer* its decay time.

Notes

- The number of previous values considered in the average difference calculation can be modified during runtime.

Competitive Analysis: Cumulative

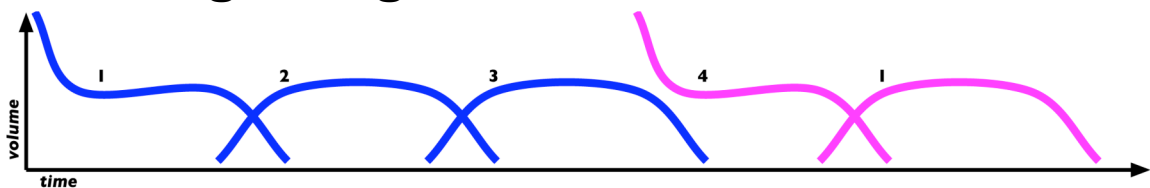
Goals

- Rank all groups based on how long they have been the winner over the course of the entire performance.

Technique

- Use an array to track the total amount of time each group has been the winner.
- Rank groups by sorting the total winning times.

Musical Logic: Single Sustained Note



In this figure, the numbers above each curve indicate which musician within a group plays it, and the color families of each curve indicate which note within the pitch set is being played (see Color Map below).

Instantaneous Volume

- The instantaneous volume is taken from the group data. When 0% of a group's light sticks are on, the group is silent (0); when 100% of a group's light sticks are on, the group plays at maximum volume (1).

Crossfading

- Each player within the group starts playing from *niente*, then *crescendos* to the instantaneous volume, then *decrescendos* to *niente*. Player entrances are staggered so that the sum of all player volumes is always equal to the instantaneous volume.
- The crossfade rate is based on the group data. When just over 0% of a group's light sticks are on, the group takes 6 seconds to crossfade from one player to the next; when 100% of a group's light sticks are on, the group takes only 1.5 seconds to crossfade.

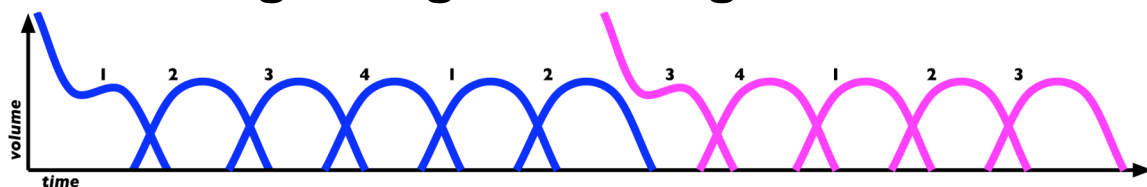
Note Selection

- Notes are chosen from an ordered, looped sequence of 1, 2, 3, or 4 pitches.
- Each group has a different set of available pitches, and different subsets of those pitches are available at different points within the piece (see Pitch Map and Timeline below).
- Whenever the group becomes the winner of the instantaneous competitive analysis, it moves to the next pitch in the sequence.

Accents

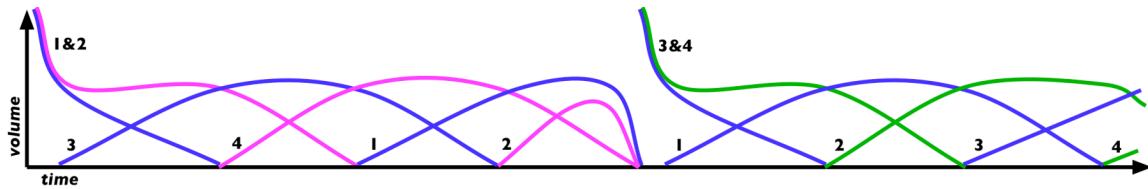
- Whenever a group becomes the winner of the instantaneous competitive analysis, it accents its note. This corresponds with a note change, except at the very beginning of the piece, where the pitch sequence contains only one note.
- The accent is played by a single musician in the group.

Musical Logic: Single Pulsating Note



This is identical to the Single Sustained Note section above, with one critical difference: the crossfades are much faster: between 0.9 seconds and 1.65 seconds. So it sounds more like a slowly pulsating note — with fairly sudden changes at regular time intervals — than a sustained note with a slowly evolving timbre.

Musical Logic: Two Note Clusters

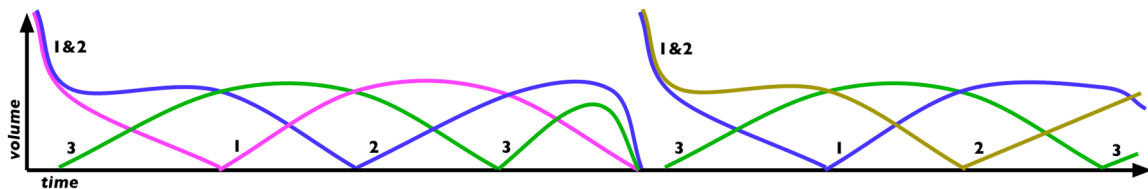


This is similar to Single Sustained Note and Single Pulsating Note, but two different notes are always played simultaneously by the group. At any given moment, one of the players is always at the peak of a crossfade, one player is in the *crescendo* portion of a crossfade, and one player is in the *decrescendo* portion of a crossfade. In four-player groups, one player is always silent.

The crossfade rate is slower than for Single Pulsating Note but faster than for Single Sustained Note: between 1.35 seconds and 2.7 seconds.

Accents are played by two musicians in the group.

Musical Logic: Three Note Clusters



Two different notes are played simultaneously by the group, but with each successive crossfade, those notes rotate through all possible two-note subsets of a three-note set. Accents are played by two musicians in the group.

Data Scaling

Goals

- Scale the player volumes based on instantaneous group rankings, so that the maximum possible volume is higher for groups with higher rankings.

Technique

- Scale player volumes using the following formula:

$$\text{scaledVolume} = \text{volume} * (1.0 - 0.07 * (\text{groupRank} - 1))$$

(*volume* varies between 0.0 and 1.0)

- When rankings change, move *groupRank* to its new value gradually over two seconds, rather than suddenly jumping to the new value.
- When a group becomes the winner, update *groupRank* immediately.

Color Generation

Goals

- Convert data on pitch and volume for each player into a color in a 24-bit RGB color space.
- Give short preparation cues.

Technique

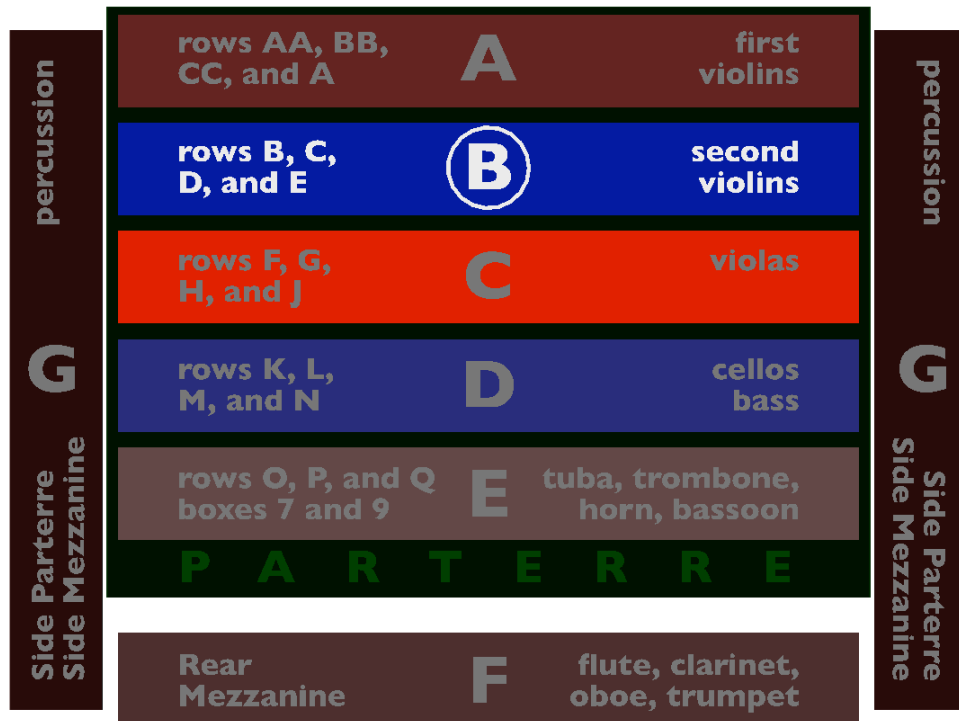
- Compute a color to represent the data in HSL (hue-saturation-luminosity) color space:

note	hue (0-255)	color
lowest	32	brown
second lowest	96	green
second highest	160	blue
highest	224	pink
saturation (0-255)		
always 255		
volume (0-1)	luminosity (0-255)	brightness
0 (tacet)	0	black
just above 0	16	very dark
1.0	112	very bright

- Give a 700 ms preparation cue for unaccented notes which begin from *niente*:
 - Compute hue and saturation as above.
 - Set luminosity to 13 (very dark) for 350 ms, then to 5 (extremely dark) for 350 ms.
- Give a 700 ms preparation cue for accented notes (which usually correspond to color changes as well):
 - Compute hue and saturation as above.
 - Set luminosity to 165 (extremely bright) for 350 ms, then to 6 (extremely dark) for 350 ms.
- Convert the HSL color to an RGB color.

For additional information and illustrations, see Color Map below.

Video Rendering



Goals

- Provide visual feedback to the audience to help them better understand the connection between their actions and the music they hear:
 - Show the raw audience data and the instantaneous volume for each group.
 - Show which group is the current winner.
 - Show which type of musical logic each group is using.
 - Show which groups have become tacet for the remainder of the piece.

Technique

- Draw a rectangle for each group and position it in a two-dimensional space to match the group's location in the audience. Label it with information about the musicians and audience members in the group. (The figure above is from the 25-player version of the piece, not the 15-player version.)

- Fill each rectangle using two superimposed rectangles which alpha-blend to create a single perceived fill color.
- Fill the lower rectangle in grey based on the group’s raw audience data. RGB values vary from (0, 0, 0) for 0.0 audience data to (102, 102, 102) for 1.0 audience data.
- Fill in the upper rectangle based on the group’s instantaneous volume and light-stick color:
 - Red-stick groups vary from RGB values (0, 0, 0) to (255, 0, 0) as instantaneous volume varies from 0.0 to 1.0.
 - Blue-stick groups vary from RGB values (0, 0, 0) to (0, 0, 255).
- Set the alpha value of the upper rectangle based on the group’s current musical logic:

musical logic	alpha value	color
tacet	0	grey
single sustained note	64	pastel red or blue
single pulsating note	128	normal red or blue
two or three note clusters	255	bright red or blue

- Draw a circle around the current winner’s group name.
- When a group becomes tacet for the rest of the piece, fade its rectangle and its label to black, so that the group is no longer visible.

Notes

- Video is rendered at 1280 x 1024 pixel resolution at a minimum of 14 frames per second.

High-Level Hardware Overview

Audience Light Sticks

Buzline Light-up Stirrers

- 4” single-color battery-operated stick with ultra-bright LED bulb.
- Simple, silent twist of cap turns on and off.



SKU 1040650 (red) and 1040651 (blue)

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<http://www.ipromoteu.com>

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4343 West 62nd Street
Indianapolis, IN 46268
(317) 876-3413
<http://www.buzline.com>
<http://www.buztronics.com>

Video Cameras and Digitizer

Four Sony consumer-grade miniDV camcorders capture images of the entire audience; mounting hardware and locations vary with each venue. In some venues, the cameras will need to be fitted with wide-angle lens adapters.

The Sony cameras provided:

- Adequate video resolution.
- Good performance in low-light conditions.
- Analog video outputs. (Long cable runs with digital IEEE1394 cable would have been prohibitively expensive.)
- Convenient image monitoring via built-in LCD screens.

Analog outputs from the four cameras are converted from RCA to BNC format and routed through to a control room backstage. These four video feeds are sent to a CCTV Color Quad Processor (e.g. SuperCircuits QS29), which outputs a single 720 x 480 pixel resolution video feed showing all four cameras. (Each camera occupies one 360 x 240 quadrant of the image.) From there, the single video feed is digitized into a 720 x 480 DV stream using a Canopus ADVC-55 digitizer and fed into the video analysis computer via IEEE1394.

Contact

SuperCircuits, Inc.
One SuperCircuits Plaza
Liberty Hill, Texas 78642
(800) 335-9777
<http://www.supercircuits.com>

Canopus Corporation
711 Charcot Ave.
San Jose, CA 95131
(888) 899-EDIT
sales@canopus.com
<http://www.canopus.com>

Computers

Two Apple Powerbook laptop computers run in the control room backstage: a video processing computer and a control computer. Each computer has at minimum an 800 Mhz G4 processor, 768 MB of RAM, and dual-display support.

Both computers run standalone, double-clickable applications which were built using Cycling '74's Max 4.5 and Jitter 1.2 environments on Mac OS X 10.3.7 ("Panther") or higher.

The software is self-configured based on each machine's hard-coded IP address:

- 10.0.1.100: control
- 10.0.1.102: video

All computers reside on a subnet with mask 255.0.0.0 in order to communicate properly with the Color Kinetics power supplies (see Musician Lights below).

The four computers and four Color Kinetics power supplies were connected via an 8-Port 10/100 Auto-Sensing Ethernet Switch.

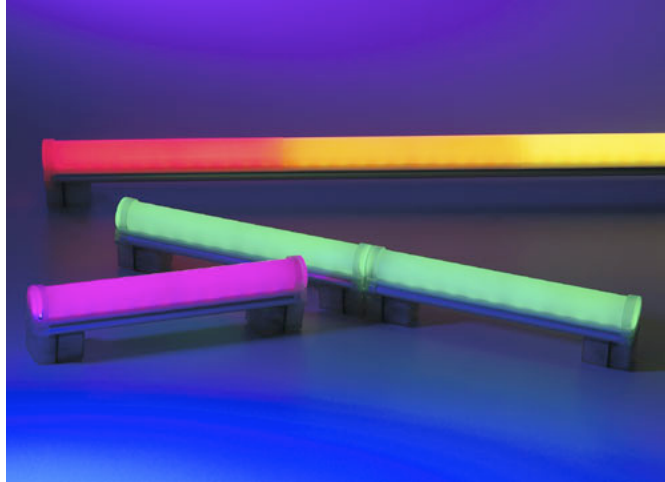
Musician Lights

Each musician has a 1-foot Color Kinetics iAccent LED light resting on the lip of his or her stand. These lights provided:

- 24-bit RGB color space.
- Low latency and high frame-rate.
- Quiet operation.
- Easy real-time control from computer via proprietary Ethernet / UDP protocol.
- Independent control of each light.
- Minimum of cabling: single cable for power / data, daisy-chain capability.

The iAccent lights are controlled by two Color Kinetics PDS-500e power supplies on the sides of the stage. Each power supply has two 25-foot leader cables, each of which lead to the first light in a musician group; and a 100-foot Ethernet cable, which leads to the Ethernet switch in the control room. Additional lights in each musician group are daisy-chained to the first light using 10-foot jumper cables. (Multiple power supplies are required because of a 74-foot limit on each cable run.)

A single Smart Jack 3 USB adapter is used to configure the DMX address on each iAccent light when they are delivered but is not needed during rehearsal or performance of the piece.



Contacts

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Color Kinetics Incorporated
10 Milk Street Suite 1100
Boston, MA 02108
csp@colorkinetics.com
(617) 701-2287
(617) 482-8610 fax
<http://www.colorkinetics.com>

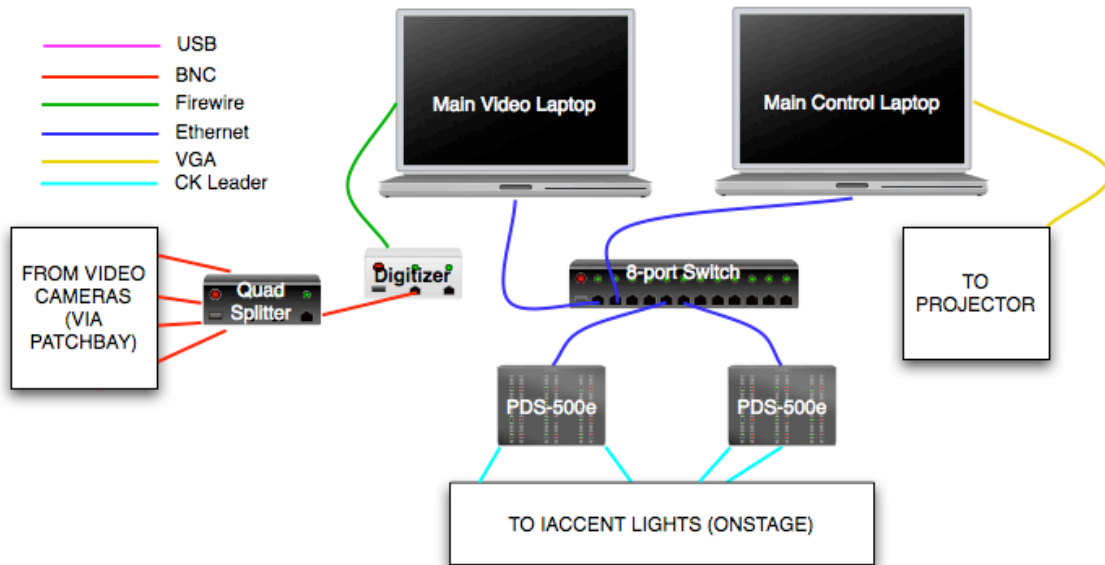
Doug Vierling
XS Lighting and Sound (rental)
1 Goldenwood Circle
Central Islip, NY 11722
Phone: 516-933-8881
Fax: 516-933-8885

Video Projection

VGA output at 1280 x 1024 pixel resolution @ 60 Hz from the control computer is routed to the venue's projector. Depending on the length of cable runs and the venue's projector, a signal amplifier and/or format converters may be necessary.

Wiring Diagram

Wiring diagram of equipment in the backstage control room:



Notation

Score

The remainder of this score describes *Glimmer* with means most closely resembling traditional music notation.

Pitch Map

The first part of the pitch map shows the four-note set available to each group of musicians. These pitch sets do not change over the course of the piece. However, in different portions of the piece, groups are limited to subsets of pitches; these are shown in the second part of the pitch map.

Color Map

The color map explains the meaning of the multi-colored lights mounted on each musician's stand. The meaning of colors does not change over the course of the piece.









Timeline

The timeline shows changes to the musical logic over the course of the piece (see High-Level Software Overview above). These parameter changes are automatically cued at specific points in time during the performance. Usually, they do not trigger immediate musical changes, but rather alter the rules by which future audience data is transformed into instructions for the musicians.

The five staves denote instantaneous rank of the musician groups (see High-Level Software Overview above). There is no fixed mapping of staves to musician groups; the mappings frequently change as the algorithm updates its analysis.

Beginning at 7'30", musician groups drop out of the piece one by one until only one group remains at 9'45". The order in which groups drop out is determined by the cumulative competitive analysis, not by instantaneous competitive analysis. So when the group with the lowest cumulative rank drops out at 7'30", that particular group remains tacet for the rest of the piece.

The following figure defines the meaning of the markings used in the timeline:

Symbol	Musical Logic	Pitch Selection
(blank)	tacet	
	single sustained note	from 1-note subset
	single sustained note	from 2-note subset
	single sustained note	from 3-note subset
	single sustained note	from full 4-note set
	single pulsating note	from 3-note subset
	single pulsating note	from full 4-note set
	two note cluster	from full 4-note set
	three note cluster	from full 4-note set

Parts

Each musician's part includes:

- Portions of this score, including "About the Piece," "Duration," "Instrumentation," "Notes for the Performers," and "High-Level System Overview."
- Customized versions of sections of this score, including "Notes for Specific Instruments," "Notation," "Pitch Map," and "Color Map."

- The supplementary DVD and a description of its contents.
- A single-page large-print “cheat sheet” to sit on each player’s music stand during the performance.

Pitch Map

Each of the five groups of musicians plays only four different pitches over the course of the piece. The following figure shows the pitches available to each group; the colors of the noteheads correspond to the color families of the light cues (see Color Map below).

	<p>GROUP A Violin I-1 Violin I-2 Violin I-3</p>
	<p>GROUP C Viola 1 Viola 2 Viola 3</p>
	<p>GROUP B Violin II-1 Violin II-2 Violin II-3</p>
	<p>GROUP D Cello 1 Cello 2 Cello 3</p>
	<p>GROUP E Bass 1 Bass 2 Bass 3</p>

The following figure shows which pitches are available to each group under different musical logic systems (as indicated by the graphical symbols used in the timeline), and the sequence of pitches within those systems. The colors of the noteheads correspond to the color families of the light cues (see Color Map below).

Musical Logic:

The musical score consists of five staves labeled A, C, B, D, and E. Above the staves are graphical symbols representing musical logic systems. The first system shows a blue line. The second system shows a green line and a blue line with the word "or" below them. The third system shows a red line. The fourth system shows a red line with a blue line underneath it. The fifth system shows a red line with a blue line underneath it. The notes in the staves are color-coded to match these families: blue, green, red, and purple. The notes are arranged in a sequence that changes across the six measures.

Color Map

Multi-colored lights mounted on each musician’s stand provide information about pitch, dynamics, timbre, and accents.

Sustained Notes

<p>Color families indicate which of the group’s four notes to play:</p>	<p>Continuous changes in brightness indicate changes in dynamics and timbre (brighter = louder).</p> <p><i>poco sul tasto</i> ————— (strings only) ————— <i>poco sul ponticello</i> <i>non vibrato</i> ————— (all except percussion) ————— <i>poco vibrato</i></p> <p><i>pp</i> ————— <i>ff</i></p>
highest note (pink)	
2nd highest note (blue)	
2nd lowest note (green)	
lowest note (brown)	

Tacet

When the light is black, do not play.

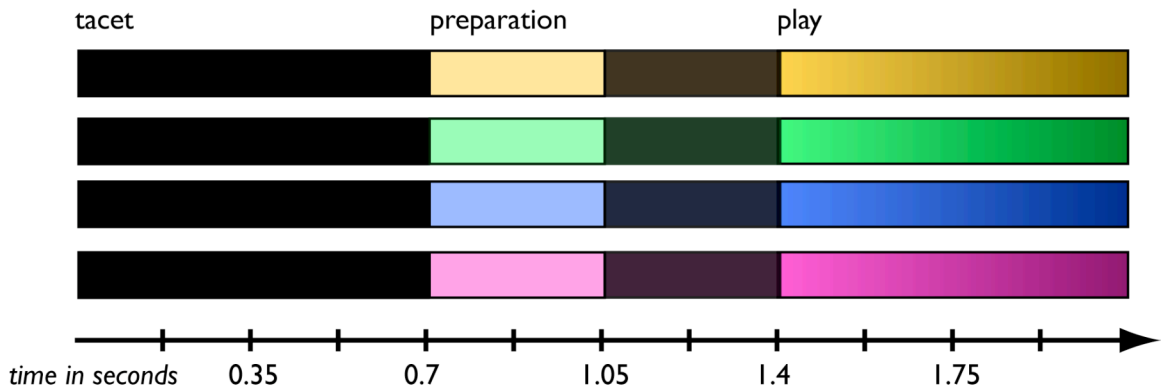
Preparatory Cues

0.7-second preparatory cues are given before sudden changes.

Accented Attacks

0.35 seconds of very bright light is followed by 0.35 seconds of very dark light, which is followed by the beginning of the note. The color family of the preparatory cue is the same as the color family of the note it cues.

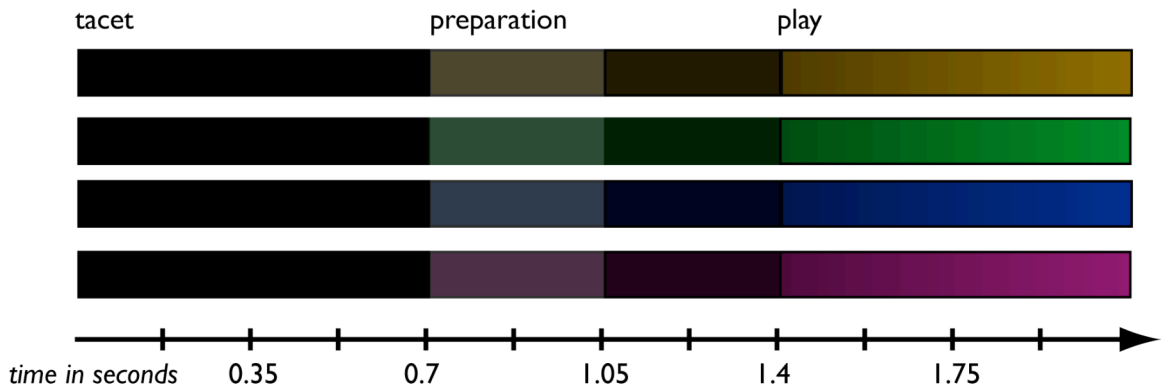
The figure below shows how these accented preparatory cues are given for each of the four color families. Occasionally, the preparation immediately follows the previous note, rather than silence as in this figure. In these cases, leave a short gap of silence between the previous note and the new attack.



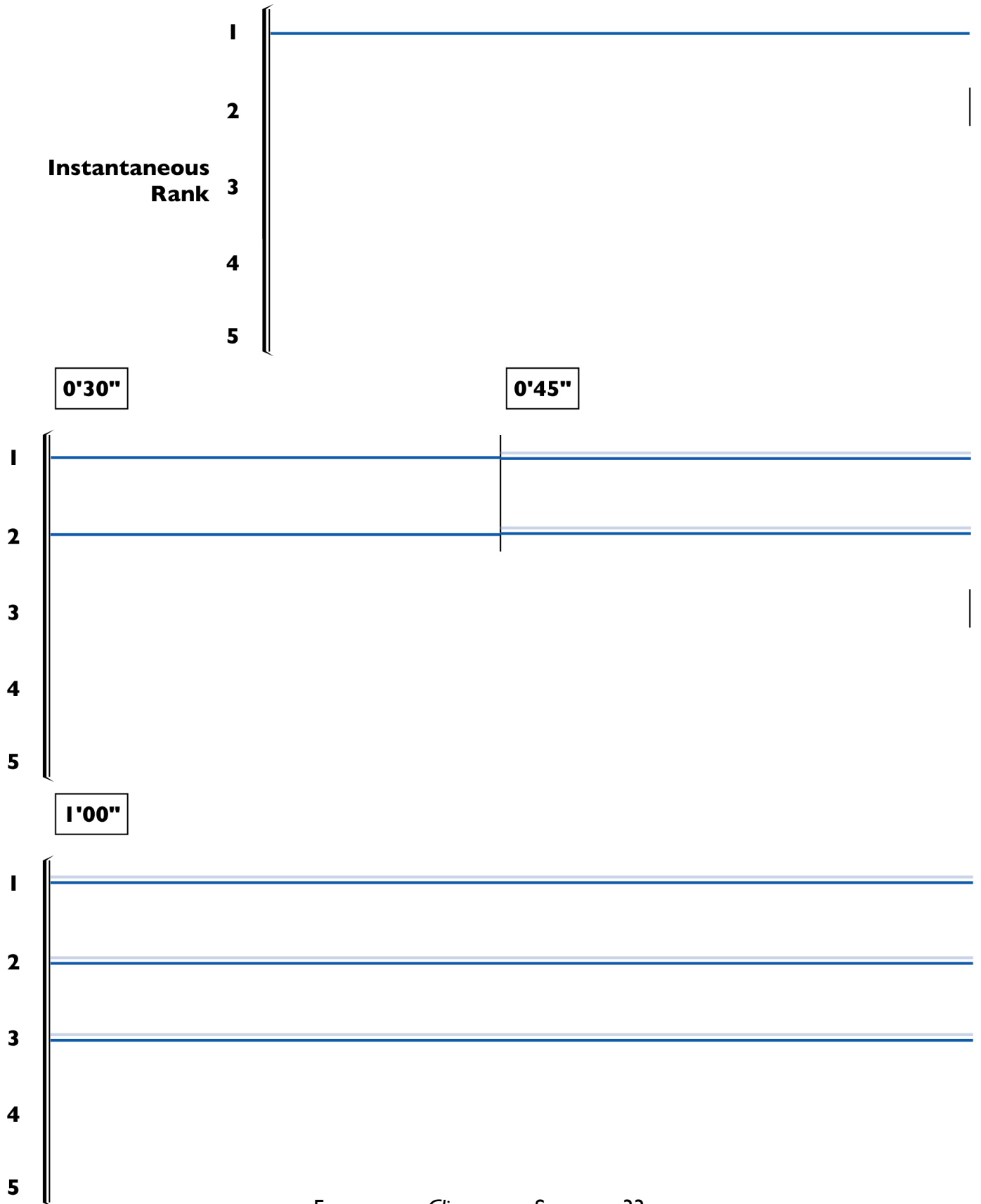
Unaccented Notes

0.35 seconds of very dark light is followed by 0.35 seconds of extremely dark light, which is followed by the beginning of the note. The color family of the preparatory cue is the same as the color of the note it cues.

This figure shows how these unaccented preparatory cues are given for each of the four color families.



Timeline



1'30"

1'45"

2'00"

2'15"

2'30"

2'45"

3'00"

3'15"

A handwriting practice grid with five rows labeled 1 to 5 on the left. Row 1 contains a series of green scalloped arches. Row 2 contains a series of green scalloped arches. Row 3 contains a solid blue horizontal line from the start to a vertical line at 3:15, followed by green scalloped arches. Row 4 contains a solid blue horizontal line. Row 5 contains a solid blue horizontal line.

3'30"

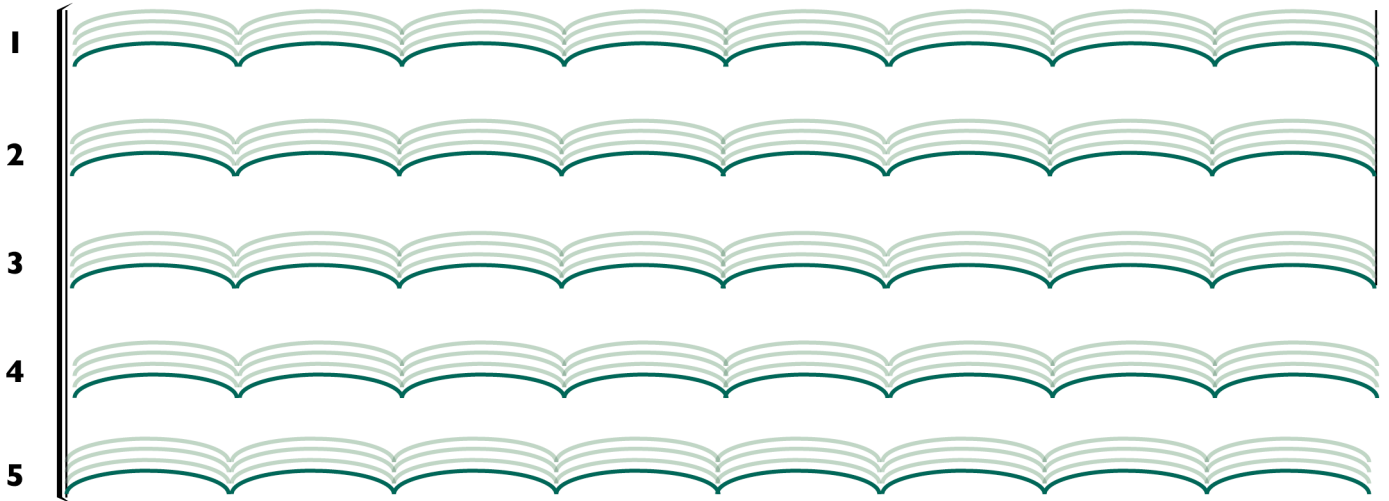
3'45"

A handwriting practice grid with five rows labeled 1 to 5 on the left. Row 1 contains green scalloped arches from the start to a vertical line at 3:45, followed by more green scalloped arches. Row 2 contains green scalloped arches from the start to a vertical line at 3:45, followed by more green scalloped arches. Row 3 contains green scalloped arches from the start to a vertical line at 3:45, followed by more green scalloped arches. Row 4 contains a solid blue horizontal line from the start to a vertical line at 3:45, followed by a solid blue horizontal line. Row 5 contains a solid blue horizontal line from the start to a vertical line at 3:45, followed by a solid blue horizontal line.

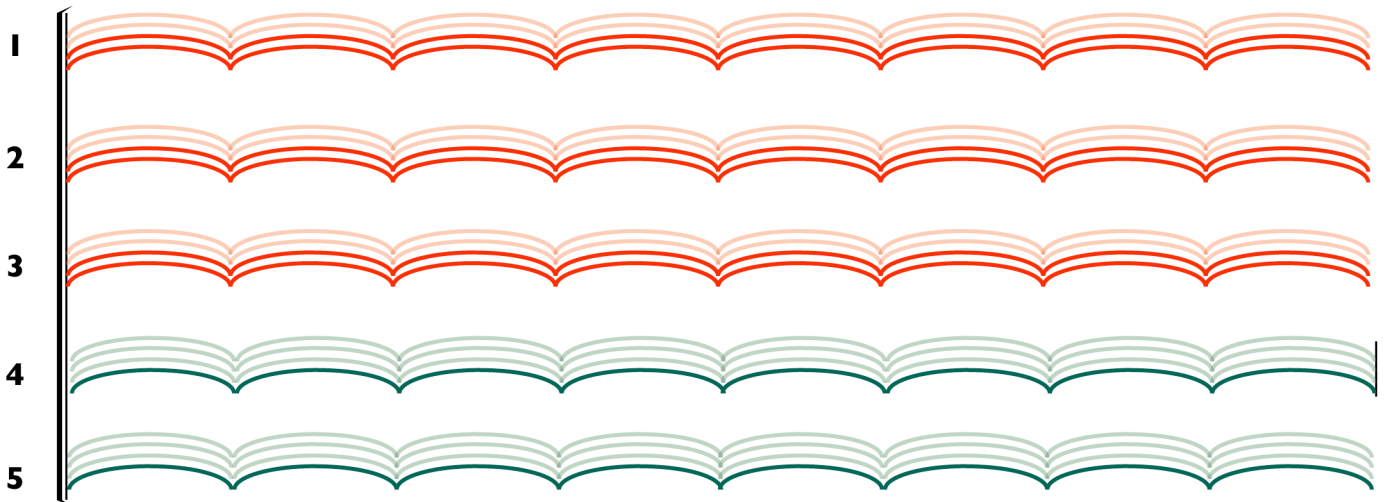
4'00"

A handwriting practice grid with five rows labeled 1 to 5 on the left. Row 1 contains a series of green scalloped arches. Row 2 contains a series of green scalloped arches. Row 3 contains a series of green scalloped arches. Row 4 contains a series of green scalloped arches. Row 5 contains a solid blue horizontal line.

4'30"

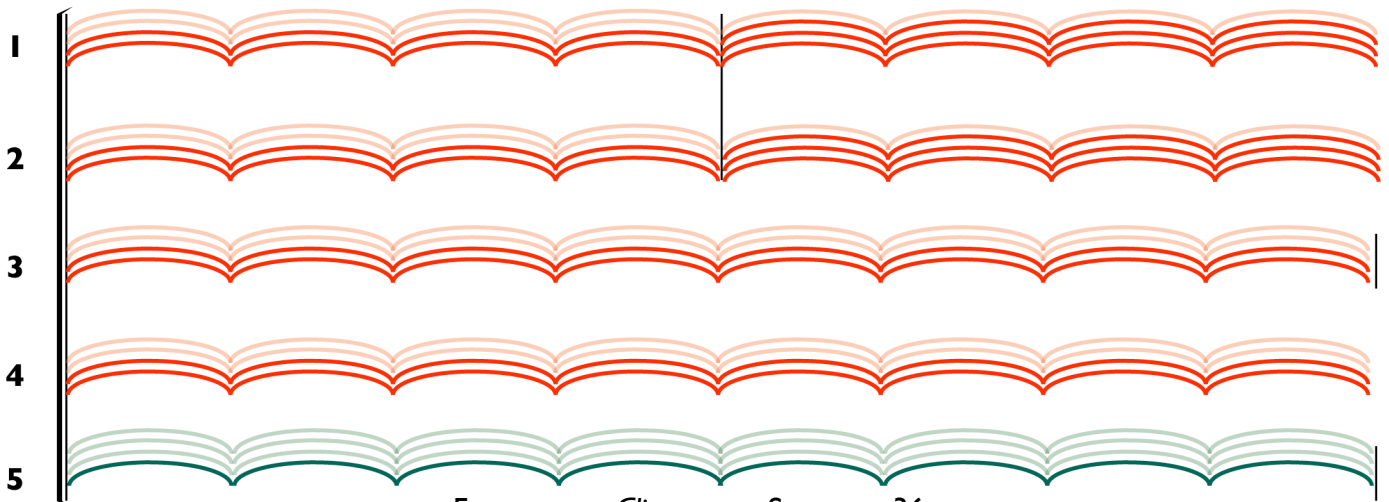


5'00"



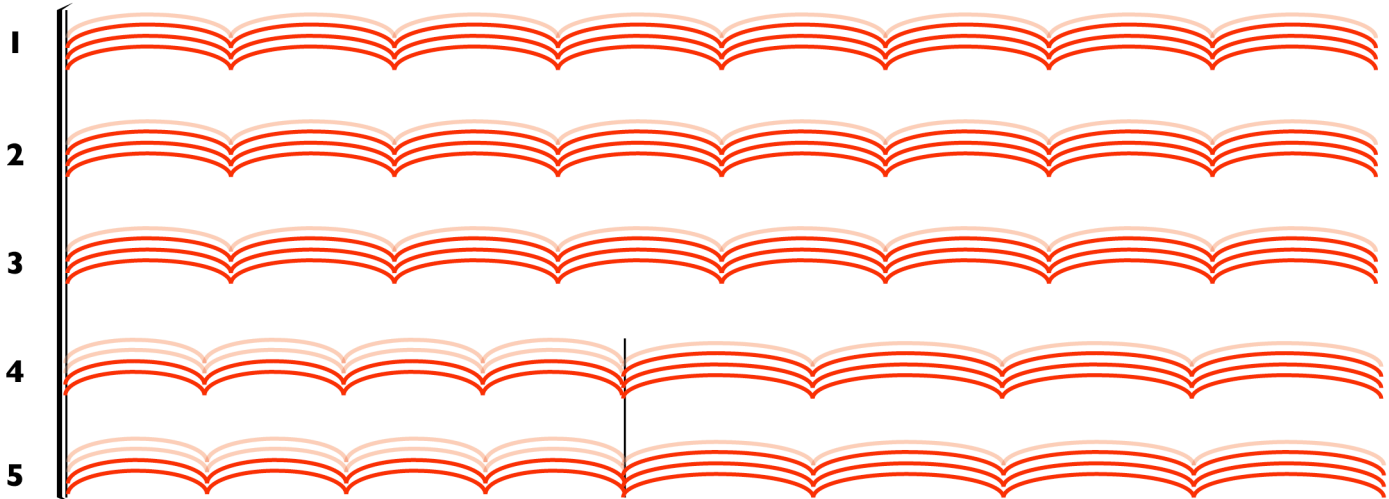
5'30"

5'45"



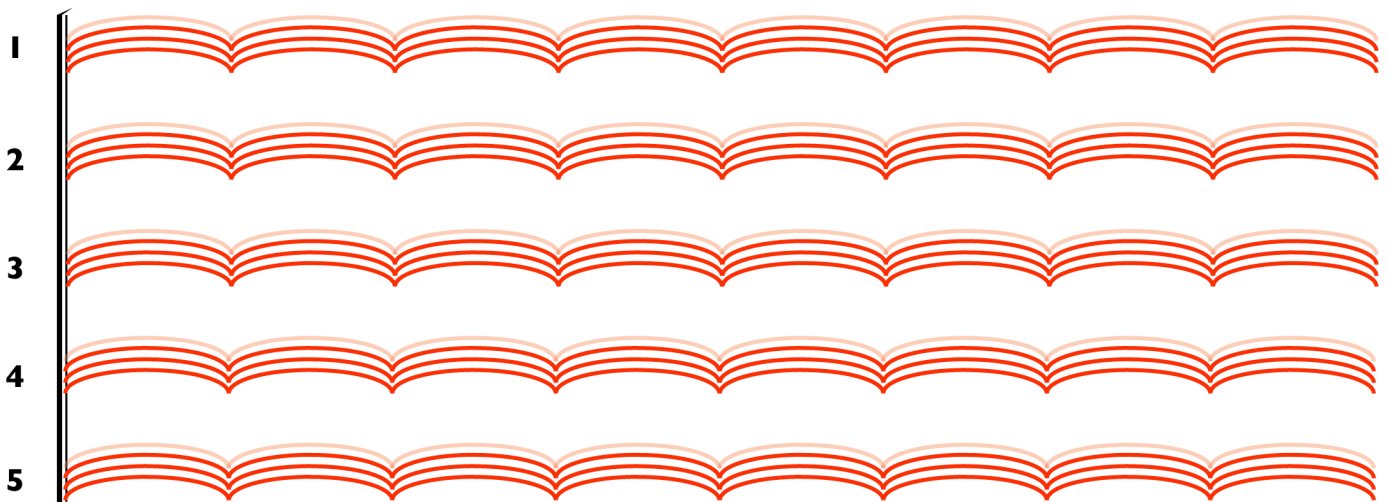
6'00"

6'15"



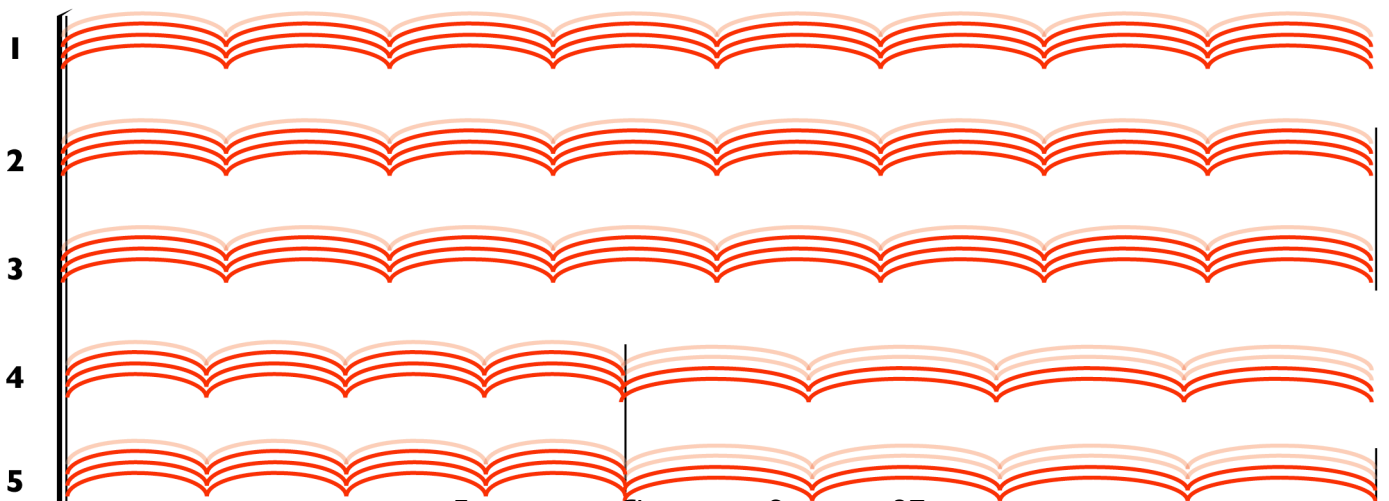
6'30"

6'45"



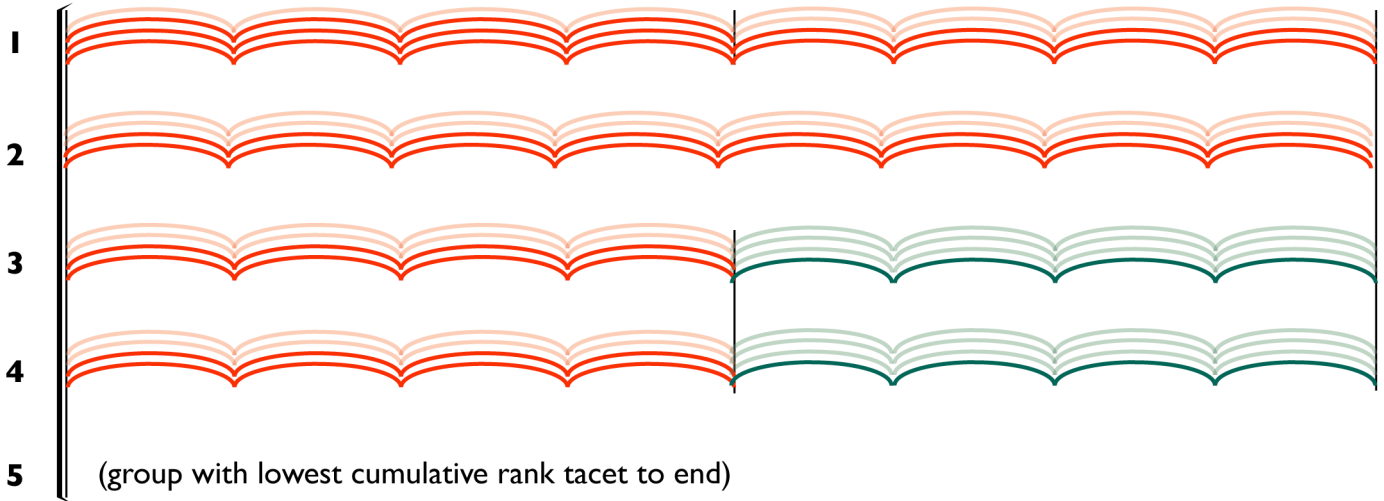
7'00"

7'15"



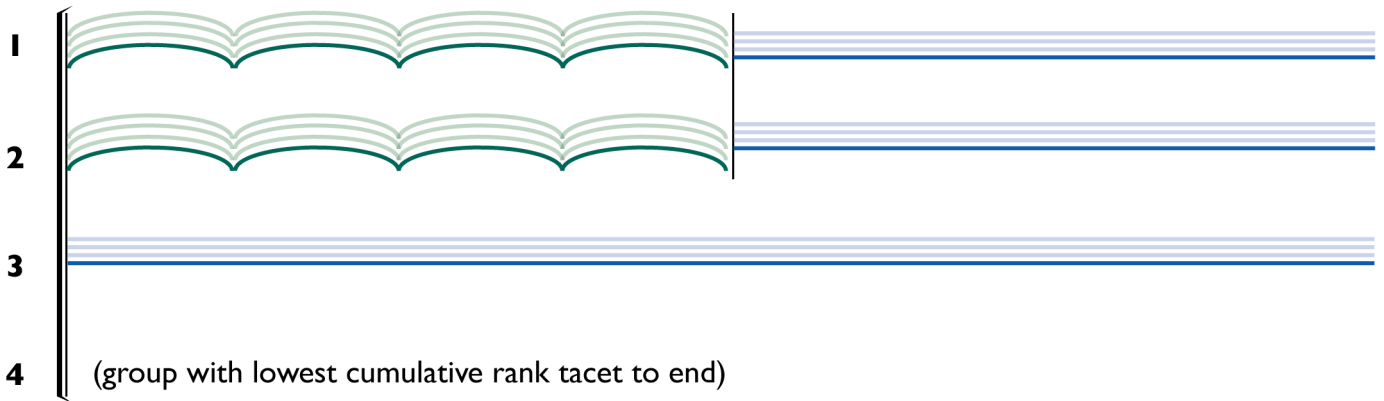
7'30"

7'45"

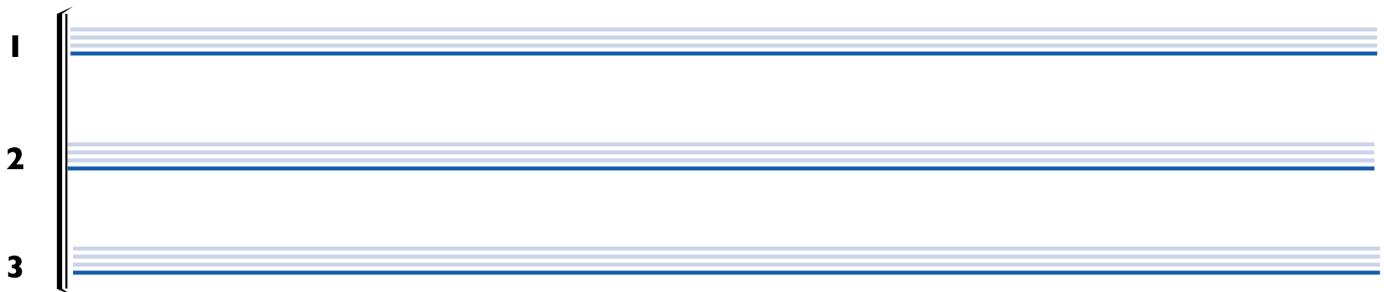


8'00"

8'15"

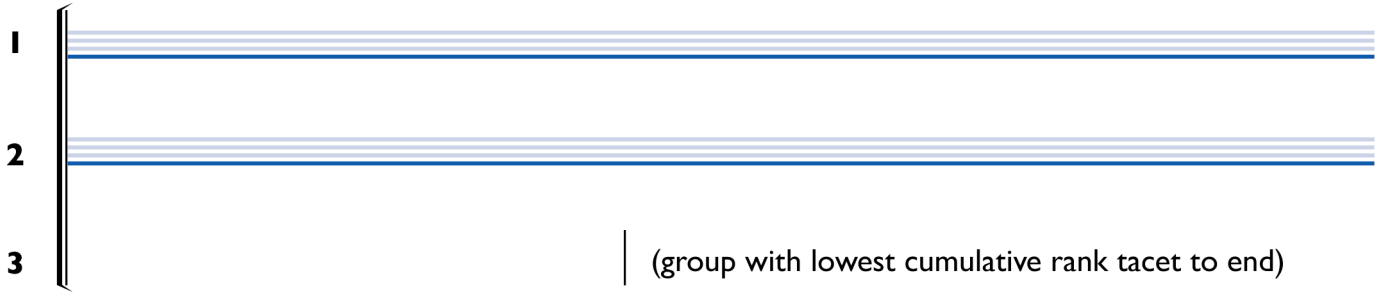


8'30"



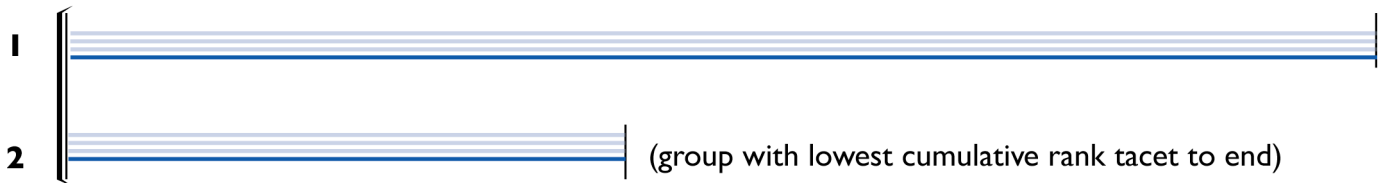
9'00"

9'15"



9'30"

9'45"



10'00"

